# Lesson 5: Oxygen, Oxidation and Combustion

American astronaut exercising aboard Russian space station; NASA

**Students are introduced to exothermic reactions that involve oxidation.**

**Main Lesson Concept:**
Oxygen is a highly reactive element involved in chemical reactions that release heat energy. Oxygen is important to humans, because it helps convert sugars into energy in the cells.

**Scientific Question:**
How does oxygen interact with other elements and molecules? How do these unique interactions affect human life?

| Objectives | Standards |
|---|---|
| • Students identify oxygen as a reactive element that benefits humans by helping to convert sugars into energy in the cells.<br>• Students explain combustion as a chemical reaction. | **Partially meets:** 2061: 4D (6-8) #6<br>NSES: B (5-8) #3.5<br>**Addresses:** 2061: 5C (6-8) #3<br>NSES: C (5-8) #1.3<br>NCTM: 4, 5, 9 |

| Assessment | Abstract of Lesson |
|---|---|
| Responses to Astro Journal final questions. | Students measure the temperature of rusting steel wool and conclude that energy is released. Students observe a candle flame and model the chain reaction that occurs during combustion and in obtaining energy from sugars. |

| Prerequisite Concepts | Major Concepts |
|---|---|
| • Plants make food from water, carbon dioxide, and sunlight in a process called photosynthesis.<br>• Oxygen helps us obtain energy from sugars. (Astronomy Lesson 1)<br>• Humans need oxygen, carbon dioxide, nitrogen, ozone, and water vapor in certain quantities. The effect on life of too little oxygen was that animals died. The effect on life of too much oxygen was that everything was on fire. (Atmosphere Lesson 1)<br>• Properties of a gas describe unique characteristics of a gas. (Atmosphere Lesson 1)<br>• The atoms of any element are alike but are different from atoms of other elements. Atoms may stick together in well-defined molecules by bonding with other atoms. (Atmosphere Lesson 2)<br>• Different molecules have different properties. Carbon dioxide and water vapor are greenhouse gases, which absorb heat radiating from Earth's surface and release some of it back towards the Earth, increasing the surface temperature. (Atmosphere Lesson 3)<br>• A chemical change or reaction occurs when molecules change or transform by combining with other substances, interchanging atoms with another molecule, or by breaking down into separate atoms. (Atmosphere Lesson 4)<br>• About 100 different elements have been identified…out of which everything is made. (2061 4D (6-8) #5) | • During some chemical reactions, energy is released.<br>• The faster the rate of the chemical reaction, the more heat is produced. If heat is produced faster than it can dissipate, combustion occurs.<br>• Oxygen is a highly reactive element that rapidly combines with other atoms and molecules.<br>• Oxygen's tendency to react also allows our cells to obtain energy from sugars. |

## Suggested Timeline (45-minute periods):

Day 1: Engage and Explore Sections
Day 2: Explore Section
Day 3: Extend and Evaluate Sections

## Materials and Equipment:

- Chemical Diagram Sheets
- A class set of Astro Journals Lesson 5
- A class set of Oxygen and Oxidation Reading
- Signs or name tags for each student to indicate the element they represent
- Vinegar to strip steel wool of protective coating

**Steel Wool Activity** (Each group will need the following):

- Steel wool that has been stripped of its protective coating
- Tape
- Thermometer (needs to be taller than the beaker; a digital thermometer or probe thermometer that can be read above the beaker work best)
- Paper towels
- Two 250-milliliter beakers
- Water
- Clock or stop watch for each group
- Spreadsheet/graphing software (optional)
- Temperature probe and data collection device such as a personal digital assistant (PDA) (optional)
- Foam insulation with draw-string top that will fit around one beaker (usually used for sports bottles)

**Observing Burning Activity** (Depending on safety requirements, you will either need one set of the following for a whole-class demonstration or one set of the following for each group. If you do a whole-class demonstration, allow each group to come and see the experiment up close.):

- Candle
- Matches
- Oven mitt
- Heat-resistant plate
- Safety goggles for each student

## Preparation:

- Gather materials.
- Prepare the steel wool by soaking it in a 250-milliliter beaker with vinegar (to remove the protective coating). Let the steel wool soak for 20 minutes.
- Duplicate Astro Journals and Oxygen and Oxidation Reading.
- Prepare chart paper with the major concept of the lesson to post at the end of the lesson.

## Differentiation

**Accommodations**

For students who may have special needs:

Have them work with a partner on the Astro Journal writing or report orally to the teacher.

**Advanced Extensions**

For students who have mastered this concept:

- Compare and contrast combustion of different substances. How does the combustion of hydrogen gas compare with methane gas or other fuels?
- Have advanced students design and conduct an experiment with steel wool by changing variables such as the amount of water, exposure to air, length of time or use of vinegar and observe the results on temperature. Have them draw conclusions about the differences in the chemical reactions that result.

## Engage

**(approximately 10 minutes)**

High-altitude research balloon carrying instruments to measure atmospheric gases; NASA

**1. Review properties of atoms and molecules (Atmosphere Lessons 1 and 2), greenhouse gases (Atmosphere Lesson 3), and chemical reactions (Atmosphere Lesson 4).**

- Question: What have we learned about the properties and characteristics of atoms?
- *Answer: The atoms of any element are alike but are different from atoms of other elements.*

- Question: What have we learned about molecules?
- *Answer: Molecules are made up of atoms. Different molecules have different properties. For example, greenhouse gases are able to absorb heat.*

- Question: How can molecules change?
- *Answer: Molecules can change by combining with other molecules, exchanging atoms with other molecules or by breaking up into separate atoms. This is called a chemical reaction.*

- Question: In a chemical reaction, is matter created or destroyed?
- *Answer: No. When molecules react, atoms may become a part of new molecules, but there is always the same number of atoms. No new atoms are created or destroyed. This is called conservation of matter.*

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**2. Draw on students' prior knowledge of reactive substances.**

- Question: How many of you have ever mixed vinegar and baking soda? What happened?
- *Answers may include: It bubbled up and spilled over the top of the container.*

- Question: Does baking soda bubble up by itself?
- *Answer: No.*

- Question: Does vinegar bubble up by itself?
- *Answer: No.*

- Question: So what do you think is happening?
- *Answer: (Allow students to discuss their ideas about this.)*

- Say: Today we're going to look at certain types of atoms that tend to combine with other substances, and what happens in these reactions.

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## 3. Bridge to this lesson and introduce the purpose and Scientific Question.

- Have students look at the Chemical Diagrams Sheet. Ask them to look at each molecule and identify the different elements that make up each molecule. (For example, water is made up of two hydrogen atoms and one oxygen atom.) Ask them to identify the element(s) that seem to show up the most.

- Question: What elements do you notice seem to be in many different molecules?
- *Answer: Hydrogen is a part of hydrogen gas, water vapor, methane, formaldehyde and ammonia. Oxygen is a part of carbon dioxide, oxygen, ozone and formaldehyde.*

- Say: You notice that oxygen is a part of many molecules. This is because one of oxygen's unique properties is that it has a tendency to react. It quickly combines with other molecules or atoms, and it is unstable on its own. Today we're going to look at how oxygen's tendency to react is important to human survival. The Scientific Questions we will explore are:
  - How does oxygen interact with other elements and molecules?
  - How do these unique interactions affect human life?

- Question: What do you already know about oxygen either from previous experience or from the Atmospheric Science Training module?
- *Answers may include: Oxygen makes up 21% of our atmosphere. The effect on life of too little oxygen was that animals died. The effect on life of too much oxygen was that everything was on fire.*

- Question: In Astronomy Lesson 1, what did we learn about the importance of oxygen for human survival?
- *Answer: We learned that oxygen helps us obtain energy from sugars.*

- Say: In the next activity, we'll look at how oxygen's tendency to react benefits human survival.

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## 4. Review the Rusting Steel Wool Activity from Atmosphere Lesson 4.

- Question: What happened when the steel wool interacted with the oxygen in the air?
- *Answer: The iron interacted with the oxygen making rust (iron oxide).*

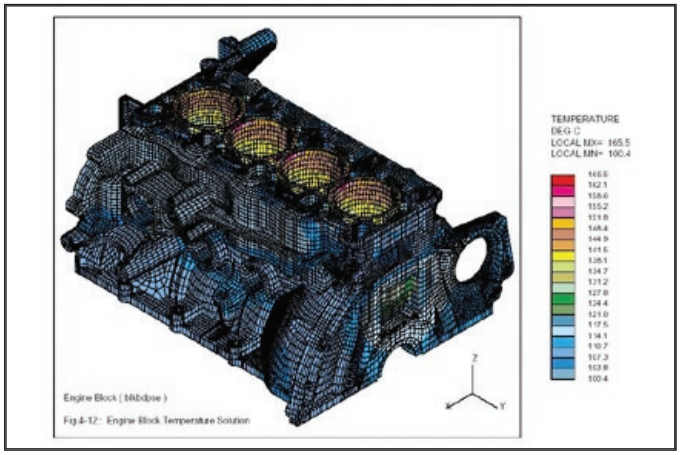
- Post the chemical reaction on the board to show students the elements that are working together to form rust: $4Fe + 3O_2$ form $2Fe_2O_3$. Explain that Fe is the symbol for iron, so four atoms of solid iron combine with three molecules of oxygen gas to form two molecules of iron oxide.

- Say: Today, you are going to perform the Steel Wool Activity by stripping it of its protective coating and exposing it to the air. You will take temperature readings throughout this experiment.

- Have students record their predictions of what will happen to the temperature in their Astro Journals and why they think that.

## Explore

**(approximately 35 minutes)**

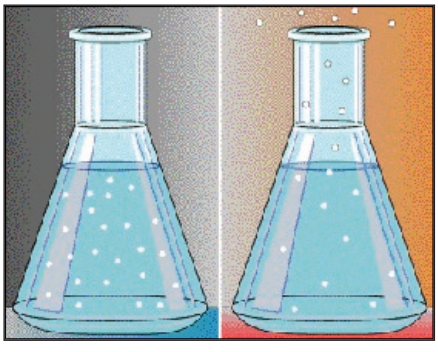



Computer modeling depicting engine block temperatures; Argonne National Laboratory, USDOE

**1. Guide students in the Steel Wool Activity.**

### Directions

1. Insert an empty 250-milliliter beaker into an insulator.
2. Take temperature measurements of the vinegar/steel wool, the surrounding room, and the insulated beaker. Record these in your Astro Journal. (The measurements of the temperatures of the surrounding room and empty beaker are to make sure that any temperature change of the steel wool is not caused by the temperature of the room.)
3. Have paper towels and tape handy.
4. Remove the steel wool from the vinegar and place into paper towels. Quickly roll up and squeeze out the vinegar from steel wool. One good squeeze should do it.
5. Immediately wrap the steel wool around the thermometer and secure with tape near the top.
6. Place the thermometer and steel wool into the insulated beaker, seal the top of the insulator, and take measurements every 10 to 15 seconds until the temperature peaks—about 5 minutes.
7. Graph the results. Be sure to start with the original temperature of the vinegar and steel wool.



Molecules in cool beaker (left) move very little; molecules in heated beaker (right) jiggle and float away; National Data Buoy Center, NOAA

**Note to Teacher: The graphing units are not provided so that students can go through the process of thinking out how best to graph their results. Suggested units are to use minutes for the x-axis, and temperature in degrees Celsius for the y-axis. Help students to decide on these units by asking such questions as, "What kind of graph will show us a change over time?" "What units will we want to use across the bottom to see this change?" "What units should we use along the side to help us see what is changing over time?"**

**Consider integrating the use of technology by having students use a spreadsheet/graphing software program to graph their results. Another technology tool that could be used here is a temperature probe connected to a data collection tool such as a personal digital assistant (PDA).**

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## 2. Discuss the results of the experiment.

- Question: What happened to the temperature around the steel wool and why?
- *Answer: It went up. As iron oxide forms, heat is released.*

- Question: Is there another reaction involving oxygen that releases heat?
- *Answer: Yes, fire. (If students don't come up with this answer, ask students what is required to get a fire going. Probe for techniques used such as blowing on the fire or making sure that there are air pockets between pieces of wood. Ask students why they think these methods help to get a fire going or keep a fire a going, and help guide them to conclude that oxygen is needed. You could also ask students what happens when you put a jar over a burning candle, and why it goes out.)*

- Say: Both iron rusting and fire (or combustion) are examples of chemical reactions involving oxygen that release heat. Rusting releases small amounts of heat energy. Burning can release small or great amounts of heat energy depending on what is burned and how it's burned.

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## 3. Facilitate the Observing Burning Activity.

- Light a candle (or multiple candles if safety allows for it).
- Have students closely observe candle.
- Students sketch the size and shape of candle and note the color of the flame.
- Students make three more sketches to show changes over time.
- Students try to explain what they are seeing as the candle burns.
- Use an oven mitt to hold a plate over the flame, and have students record what they observe
- Have students explain their observations in their Astro Journals.

**Note to Teacher: What is actually going on is contained in the Oxygen and Oxidation Reading.**

**Have students wear safety goggles for this activity, since they are working with a plate and heat.**

# Explain

**(approximately 45 minutes)**

Steady flame in laboratory; Sandia National Laboratory, USDOE

**1. Discuss student conclusions from the burning activities.**

- Question: What did you observe from watching the candle flame?
- *Answer: The melted wax traveled up the candlewick and then vaporized.*

- Question: What did you observe when you placed the plate over the flame?
- *Answer: Soot and moisture (water) formed on the plate.*

- Question: What do you think is happening in this activity?
- *Answer: (Allow students to discuss their ideas. Tell them that the following reading explains what is happening.)*

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**2. Have students read the Oxygen and Oxidation Reading.**

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**3. Discuss the reading.**

- Question: What is required to have combustion or burning?
- *Answer: You need fuel, oxygen and an initial heat source.*

- What happened during the Observing Burning Activity?
- *Answer: The candle was the fuel. As the candle heated up, the atoms moved more quickly. Some of the atoms broke free and combined with oxygen and hydrogen to form carbon dioxide and water. This released more heat energy, causing more atoms to heat up keeping the cycle going.*

- Question: What makes up the flame? What was the residue on the plate?
- *Answer: The flame was made of carbon atoms that were so hot, they were glowing. The residue on the plate was soot and water. The soot was made of carbon atoms that became cooler when they touched the cooler plate. They were too cool to burn.*

**MISCONCEPTION:** Some students think that when something is burned in a closed container, it will weigh more, because they see the smoke that was produced. The following question will help you to see if students have this misconception. Help students to conclude based on what they learned in Atmosphere Lesson 4 that there is still the same number of atoms that have recombined in a new way. The Physically Modeling Combustion Activity will also help reinforce this.

- Question: If something burned in a closed container, would it weigh less, the same or more as when it wasn't burning?
- *Answer: It would weigh the same. The smoke is a chemical change. Atoms are recombining to form a gas and are being released, but there is still the same number of atoms.*

- Tell students that in the next activity they will model the chemical reaction that takes place during combustion.

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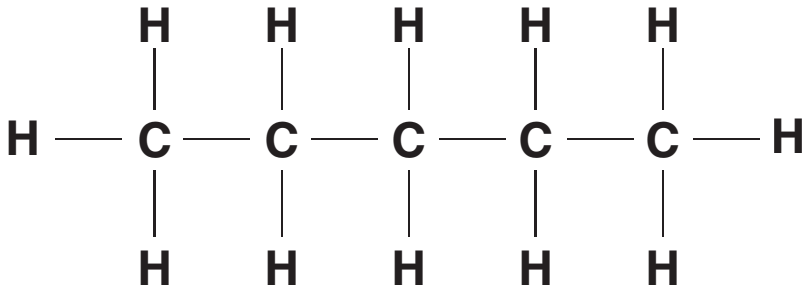
## 4. Lead students in the Physically Modeling Combustion Activity. (This activity is best conducted outside in a large open area.)

- Draw the following chemical diagram on the board. Tell students that they will be modeling this generic chain of hydrocarbons that will be the fuel for the fire they will model. You may want to have students wear a sign or name tag with the element they represent.




**Hydrocarbon Chain**

  - Modeling hydrogen requires one student who holds one hand out to "bond" with another atom while keeping the other hand at his or her side. Modeling carbon requires two students back-to-back both holding out two hands to "bond."

  - Modeling a chain of hydrocarbons requires two students standing back to back to represent each carbon atom. The carbons on the two ends should hold the hands of three students modeling hydrogen atoms and one hand of the carbon atom next to them. The two students who compose the inside carbon atoms should each hold one hand of the next carbon atom and the hand of one hydrogen atom. (18 students will be needed to model this chain.)

- Discuss combustion.
  - Question: What do we need for combustion to take place?
  - *Answer: We need oxygen, fuel and an initial source of heat.*

– Say: This chain of hydrocarbons is our fuel. Now we need some oxygen.

- Have another group of students model oxygen gas atoms.
  – Modeling oxygen gas requires two students who hold both hands out to "bond" with each other. (Each student represents one oxygen atom.)
  – In order to "burn" the entire chain, 7 molecules of oxygen gas will be needed, which will require 14 students.

- Start the reaction.
  – Say: Now we need an initial source of heat, so let's pretend that lightning has struck to provide this heat source.
  – Start at one end of the chain.

- As the bonds between the hydrogen and carbon weaken, oxygen atoms come in and grab hydrogen atoms to form water and carbon atoms to form carbon dioxide.
  – To form carbon dioxide, two oxygen atoms keep their two arms outstretched and join hands with the carbon atom.
  – To form water, one oxygen gas molecule separates into two oxygen atoms. Each oxygen atom keeps their two arms outstretched and each joins the hand of two hydrogen atoms.

- This releases more heat, which keeps the reaction going.

- Discuss the chemical reactions of combustion.
  – Question: What is happening in this reaction?
  – *Answer: Hydrogen and carbon combine with oxygen to make water and carbon dioxide. The reaction causes more energy to be released, which initiates the next reaction. The reactions keep going through the chain of hydrocarbons.*

  – Question: What would be needed to stop the reaction?
  – *Answer: Either the fuel needs to be used up or we need to get rid of the oxygen.*

**Note to Teacher: In reality, the reaction is a little more complex. This activity presents only the basic idea.**

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## 5. Discuss oxygen's role in chemical reactions.

- Question: What did we learn from the Steel Wool Activity?
- *Answer: We learned that energy is released.*

- Say: Sometimes when molecules rearrange their atoms during a chemical change or reaction, energy is released.

- Question: How does the amount of energy released during the Steel Wool Activity compare to the amount of energy released in burning?
- *Answer: More energy is released in burning.*

- Question: What do you think causes this greater release of energy in burning?
- *Answer: (Allow students to discuss their ideas about this. Then help them to draw the conclusion that the rate of the reaction in burning causes a greater release of energy. The chemical reactions occur so fast that they generate a great deal of heat that dissipates slower than it is created, and so combustion results.)*

- Question: What is oxygen's role in rusting and burning?
- *Answer: Oxygen is highly reactive and quickly combines with other atoms or molecules. Since it reacts so rapidly, it helps to generate more energy in chemical reactions.*

- Question: We've been discussing oxygen's tendency to react. How might this be important to human survival?
- *Answer: (Allow students to discuss their ideas about this. Students may point out that fire keeps us warm in the winter. Ask students how fire can also be harmful to life. Encourage students to think about how oxygen's tendency to react might be important in other chemical reactions in the body.)*

- Say: In the next activity, we'll look at how oxygen's reactivity is vital to human survival.

## Extend/Apply

**(approximately 25 minutes)**

Photosynthesis: green plants capturing energy from sunlight and converting it into chemical energy; Lawrence Berkeley National Laboratory, USDOE

**1. Lead students in the Photosynthesis and Aerobic Respiration Activity.**

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**2. Draw on students' prior knowledge of sugar.**

- Question: Think of a time when you ate a lot of candy, soda pop or cake. You might have done this on Halloween or at a party. How did you feel? How did you behave?
- *Answers may include: I was hyper. I had a lot of energy.*

- Question: What was it that caused you to feel or act this way?
- *Answer: The sugar made me hyper.*

## 3. Discuss photosynthesis.

- Say: We do get energy from sugar, but we need oxygen to release the energy from sugars. Before we can look at how oxygen helps us get energy from sugars, let's first understand where the energy comes from.

- Question: From where do we get energy?
- *Answer: We get energy from eating food.*

- Question: What kinds of food do we eat?
- *Answer: We eat plants like fruits and vegetables and grains, and we eat animals like chickens, pigs and cows.*

## 4. Draw on students' prior knowledge of plants.

- Question: Where do the plants that we eat get their energy?
- *Answer: Plants get energy from sunlight.*

- Question: What else do you know about what plants need to live and grow?
- *Answer: Plants need water, sunlight and carbon dioxide.*

- Question: What do plants produce for us besides food that is important for our survival?
- *Answer: Plants release oxygen.*

**Note to Teacher: You may want to write these ideas on the board to help students see why each of these is important in the following chemical reaction.**

## 5. Write the following equation on the board:

$$6H_2O + 6CO_2 + \text{solar energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

- Question: What molecules do you see in this chemical reaction?
- *Answer: Six water molecules combine with six carbon dioxide molecules and with sunlight to make a big molecule and six oxygen gas molecules.*

- Say: We call this process photosynthesis, which you'll learn more about in the Biology module. The big molecule that is produced is called glucose, better known as sugar.

- Question: We said earlier that plants need water, sunlight and carbon dioxide and that they put out oxygen. Why is this the case?
- *Answer: Plants use water, carbon dioxide and sunlight to make sugars and oxygen. They use the sugars for energy.*

- Question: How do you think animals might release the energy in the sugar?
- *Answer: (Allow students to discuss their ideas about this.)*

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## 6. Write the following chemical equation (aerobic respiration) on the board and discuss:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6\,H_2O + \text{energy}$$

- Question: How does this equation compare to the equation for photosynthesis?
- *Answer: It appears to be the reverse. Oxygen is reacting with glucose to form carbon dioxide and water and releasing the energy.*

**MISCONCEPTION:** Students may look at the equation for photosynthesis and aerobic respiration and think that they are opposites or are reversible; however this is not the case. There are very complex chemical processes that are involved with each, and these steps are not reversible. Also, energy is lost during these processes. This could be explained to students using the metaphor of one-way streets. You might start at point A and travel to point B using one route, but are unable to go from Point B to point A using the reverse route, because the one-way streets are traveling in the wrong direction.

- Tell students that this reaction takes place in our cells and is called "aerobic respiration." Explain that this reaction is similar to burning, except that it releases energy slowly, and much of the energy is stored in chemical form instead of being released as heat. Also explain that the actual process involves a series of separate reactions controlled by different parts of our cells. Another example of how this energy is released is when we exercise. As we move about our muscles require energy. A by-product of the muscles' work is extra heat. This is why we get hot and sweat when we exercise.

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## 7. Have students draw and explain the process of photosynthesis and aerobic respiration in their Astro Journals.

## Evaluate

**(approximately 20 minutes)**

Scientist studying plant growth systems related to space missions; NASA

**1. Have students complete their write-ups in their Astro Journals.**

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**2. Discuss students' responses in their Astro Journals to ensure that they have mastered the major concepts.**

- Question: What unique properties does oxygen have?
- *Answer: Oxygen is highly reactive, so it rapidly combines with other atoms and molecules. When oxygen reacts, heat is released, which sometimes can result in combustion or fire. Oxygen's tendency to react also allows our cells to obtain energy from sugars.*
- Question: How do these unique properties affect human habitability?
- *Answer: Oxygen's ability to help us obtain energy from sugars is vital to our survival. Some amount of oxygen is also beneficial to be able to make fires to warm us or cook our food. However, too much oxygen can result in too many fires that destroy living things.*

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**3. Collect students' Astro Journals and evaluate them to ensure that they have each mastered the major concepts:**

- Oxygen is a highly reactive element involved in chemical reactions that release heat energy.
- Oxygen is important to humans, because it helps to convert sugars into energy in the cells.

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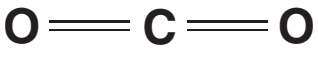
**4. Bridge to next lesson.**

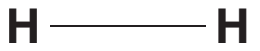
- Say: Today we learned about oxygen's unique properties and how these properties affect human habitability. In the next lesson, we will look at another molecule that is made of oxygen atoms, ozone, and how ozone is also important to human survival.

**Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the "conceptual flow" and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding.**

# Chemical Diagrams Sheet

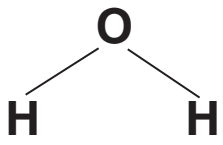



**Carbon Dioxide ($CO_2$)**




**Hydrogen Gas ($H_2$)**

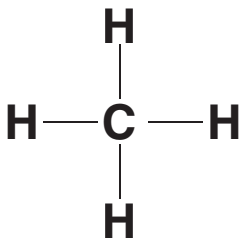

**Oxygen Gas ($O_2$)**



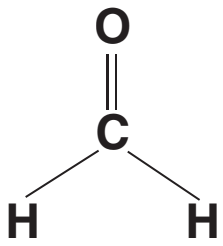

**Water ($H_2O$)**


**Ozone Gas ($O_3$)**

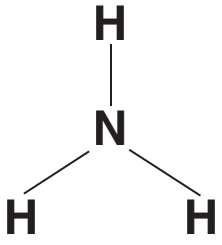

**Nitrogen Gas ($N_2$)**




**Methane ($CH_4$)**




**Formaldehyde ($CH_2O$)**




**Ammonia ($NH_3$)**

# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

## Steel Wool Activity

**Directions**

1. Insert an empty 250 milliliter beaker into an insulator.
2. Take temperature measurements of the vinegar/steel wool, the surrounding room, and the insulated beaker. Record these in your Astro Journal. (The measurements of the temperatures of the surrounding room and empty beaker are to make sure that any temperature change of the steel wool is not caused by the temperature of the room).
3. Have paper towels and tape handy.
4. Remove the steel wool from the vinegar and place into paper towels. Quickly roll up and squeeze out the vinegar from steel wool. One good squeeze should do it.
5. Immediately wrap the steel wool around the thermometer and secure with tape near the top.
6. Place the thermometer and steel wool into the insulated beaker, seal the top of the insulator, and take measurements every 10 to 15 seconds until the temperature peaks—about 5 minutes.
7. Graph the results. Be sure to start with the original temperature of the vinegar and steel wool.

(Drawing of experiment)

1. What do you predict will happen to the temperature? Why do you think that?

2. Steel Wool Activity Data Chart

Original temperature of vinegar/steel wool: _____ Temperature of surrounding room: _____ Temperature of insulated beaker: _____

| Time | Temperature | Time | Temperature |
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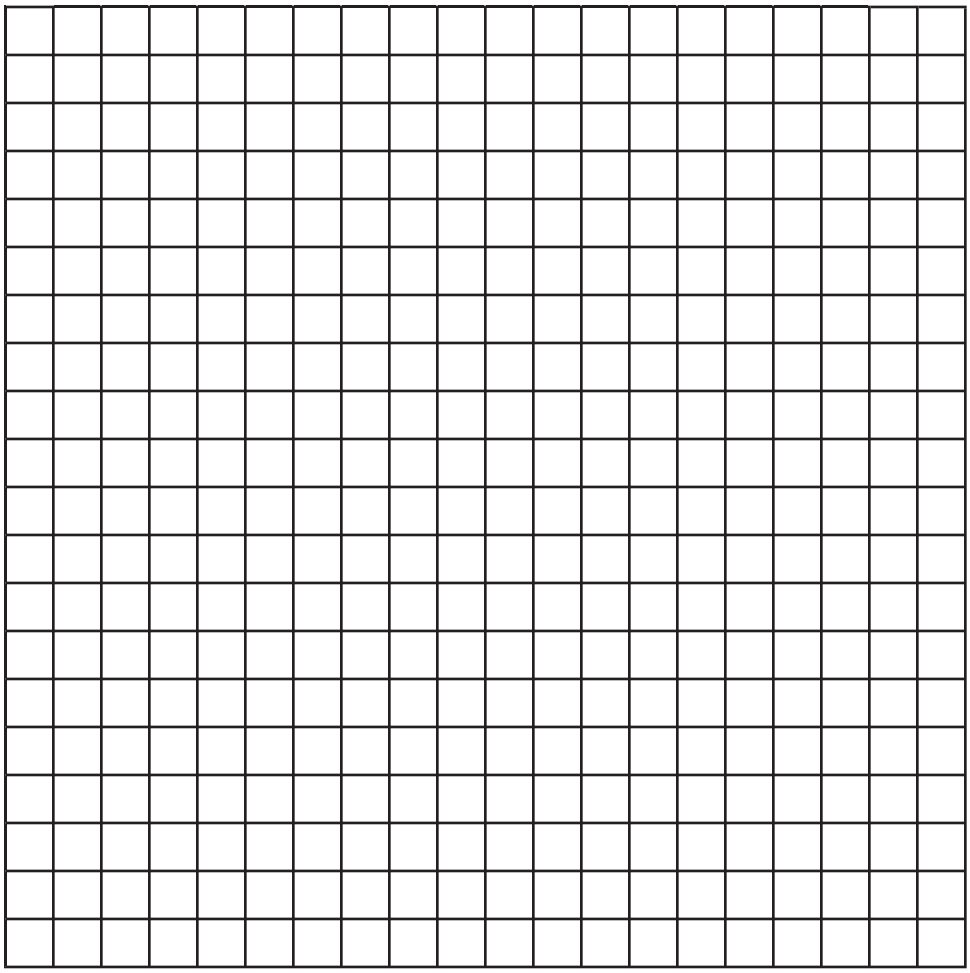
# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

3. Graph both sets of data below.



4. What happened to the temperature around the steel wool? Why?

# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

## Observing Burning Activity

**Directions**

1. Light a candle.
2. Closely observe the candle.
3. Sketch the size and shape of the candle and note the color of flame.
4. Make three more sketches over time.
5. Using the oven mitt, hold a plate over the flame. Observe and record what you see. Explain your observations.

**Data**

1. Sketch the candle and flame. Note the size and shape of the candle and the color of the flame. Make three more sketches over time.

| Sketch 1<br>Time: | Sketch 2<br>Time: | Sketch 3<br>Time: | Sketch 4<br>Time: |
|---|---|---|---|
| | | | |

# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

## Observing Burning Activity

2. Explain what changes you see in the flame and candle over time.

3. What do you observe when the plate is placed over the flame? Explain what is happening.

# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

## Photosynthesis and Aerobic Respiration

1. Draw the processes of photosynthesis and aerobic respiration and explain the chemical reactions that take place to trap and release energy.

| Photosynthesis | Aerobic Respiration |
|---|---|
| | |

# Astro Journal Lesson 5: Oxygen, Oxidation and Combustion

Name _____ Date _____ Class/Period _____

## Final Conclusions About Oxygen

1. What unique properties does oxygen have?

2. How do these unique properties affect human habitability?

# Oxygen and Oxidation Reading

Rust formed on steel cable, USGS

Oxygen is one of the most important gases for life on Earth. Most people know that oxygen is necessary for life, but not everyone can say exactly why. Oxygen is so important because of its reactivity. It reacts with many other elements and molecules, a process called oxidation. When these reactions occur, energy in the form of heat, is given off. When the reaction goes slowly, as in the case of rusting, a small amount of heat is given off. When the reaction goes quickly and can keep itself going, the reaction is called combustion. Combustion is more commonly known as burning.

Combustion or burning is a chemical reaction that requires oxygen, some sort of fuel, and an initial source of heat. Once the reaction is going, it will produce enough heat to keep itself going until it runs out of fuel or oxygen.

Combustion can only occur when there is a fuel that can react with the oxygen. Most fuels are made up of carbon and hydrogen atoms. As the fuel heats up, the atoms move more quickly. Some begin to break free from their molecules. As they do so, oxygen atoms grab the carbon and hydrogen atoms making carbon dioxide, $CO_2$, and water, $H_2O$. In this process, more heat energy is released which causes more atoms to move more quickly thus keeping the cycle going. Soot, ash, and smoke are all the remnants of incompletely burned carbon and hydrogen.

The flames themselves are carbon atoms that are so hot that they are glowing, but they have not yet combined with the oxygen atoms to form carbon dioxide or water.

During the candle observation, you put a plate over the burning flame. This left a black residue and possibly some water on the plate. When the hot carbon gas encounters the cooler plate, some of the carbon atoms cool enough so that they do not combine chemically with the oxygen atoms. This is why the black soot is left on the plate. The cooler plate also provides a place for the produced water to condense.

It is important to remember that Conservation of Matter applies to combustion.When matter is burned, it's not destroyed, it's transformed. The same amount of matter is there, just as different molecules.

Oxygen is so important for life because its tendency to react allows humans and other animals to obtain energy from sugars. This process is similar to combustion, but releases energy much more slowly and stores energy in a chemical form that does not have to be used all at once. If we did not have oxygen, our cells could not get this energy which allows us to move and drives all of the functions in our body.

Backburning of grass field to prevent wildfires; Fermi National Accelerator Laboratory, USDOE